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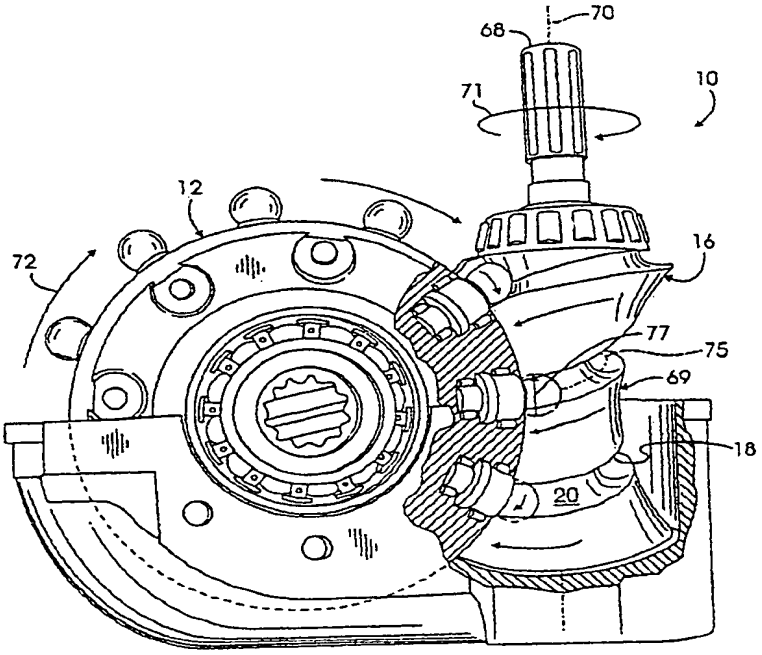
(54) Title: POWER TRANSMISSION ASSEMBLY



(57) Abstract: A power transmission system (10) having a plurality of generally round and/or spherical roller pin assemblies (14) and a screw (16) which selectively engages the pin assemblies (16) and allows power and energy to be selectively transferred by and between the assemblies (14) and the screw (16).

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POWER TRANSMISSION ASSEMBLY

(1) FIELD OF THE INVENTION

The present invention relates to a power transmission assembly and more particularly, to a power transmission assembly having a member which selectively and movably receives at least one roller pin and a selectively movable screw having at least one threaded path which selectively engages the at least one roller pin, thereby allowing power and/or energy to be selectively transferred by and between the member and the screw.

2 BACKGROUND OF THE INVENTION

Conventional power transmission systems and/or assemblies include at least one selectively rotatable screw having at least one integrally formed thread which defines a certain path, and a wheel having several integrally formed and generally fixed or stationary gear teeth which are adapted to be selectively, engageably, and movably received within the at least one thread. Particularly, as these teeth are engaged within and traverse along the threaded path, rotational force or power is partially and selectively transferred by and between the selectively engaged wheel and the rotating screw.

While these prior systems and/or assemblies allow for the selective transfer of some of this power or

energy, they suffer from a number of drawbacks. For example, a considerable amount of friction occurs between the engaged teeth and the thread causing a considerable and undesirable loss of power and energy, thereby resulting in an undesirably inefficient power transmission assembly. Additionally, this frictional engagement also causes components of the assembly to become fatigued, to fail, and to become unreliable.

It is generally known that the replacement of these gear teeth with movable rollers or "roller pins" provides for a substantial reduction in the amount of these "frictional type" energy and power loss. Particularly, the use of rollers or roller pins to substantially reduce these conventional frictional type power or energy losses and to improve the overall efficiency of a power transmission system or assembly is discussed within U.S. Patent No. 4,833,934 of Boyko et al. ("the '934 patent") and U.S. Patent No. 4,685,346 of Bracket ("the '346 patent"), both of which are fully and completely incorporated herein by reference, word for word and paragraph for paragraph.

Although the roller pin type systems disclosed in the above-referenced '934 and '346 patents are significantly more efficient than the prior gear arrangements, they too suffer from drawbacks. For example and without limitation, the movable engagement of

the rollers or roller pins with the screw thread also results in the creation of undesirable frictional or "skidding" type force. Although this force is substantially smaller than that associated with conventional gear drive type systems, it does result in undesirable power and energy loss and it does cause the assembly to become fatigued and to malfunction over some period of time. Moreover, in these prior roller systems, a "compression type" force (e.g., referred to as an "axial or thrust component" on line 1 of column 7 of the '346 patent) is also created. This compression force, applied along the longitudinal axis of the roller pins and in the direction of the center of the wheel, also causes an undesirable loss of energy and power. Hence, both of these created forces substantially decrease the overall efficiency of these prior roller pin power transmission systems and cause a substantial loss of power, thereby reducing the amount of the energy or power which is transferred by and/or communicated by and between the wheel and the screw.

Moreover, this "compression type" force also requires that a spring and/or a thrust bearing be operatively coupled to each of the provided roller pins in order to allow the roller pins to adequately absorb the downward projecting or compression type force without incurring substantial and undesirable structural damage.

These springs and/or bearings increase the overall cost of these prior roller pin assemblies and require periodic and undesirable maintenance and replacement, thereby making the assemblies prone to failure and relatively unreliable. Thus, further improvements in the overall efficiency and operation of these roller pin assemblies may be realized by substantially reducing and/or eliminating this "compression type" force and the concomitant "skidding" type frictional force arising and/or created between the various engaged roller pins and the screw thread.

There is therefore a need for a power transmission assembly which overcomes at least some of the previously delineated drawbacks of the prior power transmission assemblies; which substantially eliminates and/or reduces the "skidding" type frictional forces arising between the engaged roller pins and the screw thread; and which substantially eliminates and/or reduces the compression type force imparted upon the engaged roller pins by the screw thread, thereby substantially increasing the overall efficiency of these roller type power transmission systems and/or assemblies. Applicants' invention addresses these drawbacks, improves upon these aspects of the prior assemblies and/or systems, and provides a new and useful power transmission assembly

having improved power transmission efficiency, improved overall reliability, and being relatively cost efficient.

SUMMARY OF THE INVENTION

It is therefore a primary object of the invention to provide a power transmission assembly which overcomes at least some of the previously delineated disadvantages of prior assemblies and/or systems.

It is another object of the invention to provide a roller type power transmission assembly which overcomes at least some of the previously delineated disadvantages of the prior assemblies and which, by way of example and without limitation, substantially reduces the frictional forces arising and/or created between the engaged roller pins and the screw thread.

It is another object of the invention to provide a roller type power transmission assembly which overcomes at least some of the previously delineated disadvantages of the prior assemblies and which, by way of example and without limitation, substantially reduces the amount of the compression forces which are imparted upon the roller pins during their respective and cooperative engagement with the screw thread.

It is another object of the invention to provide a roller type power transmission assembly which overcomes at least some of the previously delineated disadvantages

of prior assemblies, which, by way of example and without limitation, has an improved power transmission efficiency, and which allows the engaged roller pins to be substantially and automatically placed, aligned, and/or "centered" within the screw thread.

According to one non-limiting aspect of the present invention, a roller type power transmission assembly is provided and includes a screw having a first threaded path and a wheel having at least one generally round roller pin which selectively engages and travels within the threaded path, thereby allowing power and/or energy to be selectively transferred by and between the screw and the wheel.

Further objects, features, and advantages of the present invention will become apparent from a consideration of the following description and the claims, when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

For a substantially fuller and more complete understanding of the nature and objects of the present invention, reference should be had to the following drawings in which:

Figure 1 is a fragmentary side sectional view of a power transmission assembly which is made in accordance

with the teaching of a first embodiment of the present invention;

Figure 2 is a sectional view of the power transmission assembly which is shown in Figure 1 and which is taken along view line "2-2";

Figure 3 is an unassembled side view of one of the roller pins shown in Figure 1;

Figure 4 is a fragmentary side sectional view of a power transmission assembly which is made in accordance with the teachings of a second embodiment of the present invention;

Figure 5 is a sectional view of the power transmission assembly which is shown in Figure 4 and which is taken along view line "5-5";

Figure 6 is an unassembled side view of one of the roller pins shown in Figure 5;

Figures 7(a-b) are side views of a power transmission assembly which is made in accordance with the teachings of a first embodiment of the present invention; and

Figure 8 is a side view of a power transmission assembly which is made in accordance with the teachings of a third embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT OF THE INVENTION

Referring now to Figures 1-3, 7(a-b), and 8, there is shown a power transmission assembly 10 which is made in accordance with the teachings of the preferred embodiment of the invention. As shown, assembly 10 includes a movable member 12 which, in one non-limiting embodiment of the invention, is substantially identical to wheel 12 of the '346 patent but which includes several substantially identical roller pins or "rollers" 14 which are different from the roller pins 38 described and shown within '346 patent. It should be realized that wheel 12 may be of virtually any desired shape and/or size and that this invention is not limited to the specific and/or exact size or shape of the wheel 12 which is shown in Figure 1.

Assembly 10 also includes a screw 16 having at least one thread 18 which defines and/or includes a certain threaded path 20 which traverses the surface of the screw 16. While a single screw 16 having a single threaded path 20 is shown and described, it should be realized that this invention is equally applicable to multiple screws 16 and/or to screws 16 having multiple threads 18 and multiple paths 25,27, such as shown for example and without limitation in Figure 8(a), and that the following discussion is equally applicable to the engagement of these rollers 14 within these multiple threaded paths 25,27. Moreover, it should be further realized that, in

the preferred embodiment of the present invention, screw 16, roller wheel 12, and roller pins 14 are all selectively manufactured from a relatively hard, durable, and commercially available substance or material, such as hardened steel stainless steel or a metal composite. It should be further realized that other commercially available and/or conventional materials may be utilized, such as and without limitation, commercially available plastic or composite materials.

Roller pins 14, in one non-limiting embodiment of the invention, are substantially similar and/or substantially identical and respectively include an integrally formed, generally rounded, and, in one non-limiting embodiment, substantially spherical shaped screw engagement portion 22 which protrudes from the outer surface 24 of member or wheel 12 when the respective roller pins 14 are properly installed within the wheel 12. The protruding pins 14 (i.e., the respective portions 22) selectively, movably, cooperatively and engageably mate with the thread 18 of screw 16, thereby rotatably traversing within the formed path 20 and upon surface 18 of the screw 16. In another non-limiting embodiment of the invention, portion 22 comprises a hemisphere, ellipse, or some other type of generally rounded shape which may be non-symmetrical.

In one non-limiting embodiment, bores 28 are positionally disposed and/or formed and/or created within the member or wheel 12 in a substantially similar manner as are bores 20 of the '934 patent, are generally cylindrical and, more particularly, are substantially and evenly distributed along surface 24. It should be realized that other bore placement patterns and/or other bore shapes may be utilized in other non-limiting embodiments of the invention. Further, as is best shown in Figures 1 through 3, each bore 28 includes a first generally narrow bottom portion 30 and a second substantially wide top portion 32. Portions 30,32 each communicatively terminate within a center portion 33, and cooperate with the center portion 33 to form the hollow bore 28. As shown, center portion 33 has a width which is larger than the width of portion 30 but smaller than the width of portion 32. Portion 32 extends through surface 24 and allows a pin 14 to be selectively placed within the bore 28.

Each roller pin 14 includes, in one non-limiting embodiment, a generally round lower body portion 34 having a height 36 of about 0.312" and a width 38 of about 0.375"; a middle body or flange portion 40 having a circumferential length 42 of about 0.131" and a width 44 of about 0.600"; a generally round top body portion 46 having a circumferential length 48 of about 0.500" and a

height 50 of about 0.510", and a generally beveled collar 52. Further, as best shown in Figure 3, point 54 which comprises a point of symmetry of portion 22 and/or comprises the "center point" of spherical portion 22 lies along the longitudinal axis of symmetry 56 of roller pin 14 and, in one embodiment, is substantially and equidistantly positioned with respect to every point, such as point 58, upon the surface of portion 22. The length 60 from point 54 to a point 58 upon surface 22 is about 0.250" and the length from the point 54 to the surface 24, when the roller pin 16 is installed within wheel 12, is about 0.200". The circumferential length along the longitudinal axis of symmetry 62 of beveled collar 52 is about 0.860".

Each bore 28, in the preferred embodiment of the invention, is adapted to movably, rotatably, and securely receive a unique roller pin 14 by the use of bearings 64 and 66 which respectively and movably reside within portions 30,32 of the bore 28 and which respectively engage body portions 34 and 46 of the roller pin 14 which is selectively contained within the bore 28. In one non-limiting embodiment of the present invention, bottom bearing 64 comprises a commercially available series SCE cage guided shell bearing having a shaft diameter of about 3/8" and which generally conforms to the size and the shape of bore portion 30, while top bearing 66

comprises a commercially available series SCE cage guided shell bearing having a shaft diameter of about ½" and which conforms to the size and the shape of bore portion 32. Other types of bearing or movable members may alternatively be used in other non-limiting embodiments, and this invention is not limited to the types of bearings 64, 66 which have been previously discussed and/or shown in the attached Figures 1-8.

To operatively install a roller pin 14 within a bore 28, a bearing 64 is first secured within the bottom most portion 32 of opening 28 (e.g., the portion of the bore 28 which is closest to the center of the wheel 12). Roller pin 14 is then inserted into the bore 28 such that portions 34,40 and 46 respectively reside within portions 30,33 and 32 of the bore 28. Top bearing 66 is then secured within portion 32, above the flange 40. Hence, flange portion 40 operatively separates top bearing 66 and bottom bearing 64, thereby allowing these bearings 64,66 to independently and movable reside within the bore 28 and allowing portion 22 of the second pin 14 to movably protrude from the bore 28 and from the movable member or wheel 12.

Bearings 64, 66 therefore cooperatively allow the contained roller pin 14 to be rotatably secured within the opening or bore 28 while substantially preventing and/or substantially limiting the amount of any outward

or inward movements (e.g., such as movements along the longitudinal axis of symmetry 56) of roller pin 14 within the opening or bore 28.

As best shown in Figures 1, 2, and 7(a-b), screw 16 typically forms and/or comprises a generally hour glass shape and typically includes two generally cylindrical shaped and opposed shafts and/or ends, such as end 68 which is best shown in Figures 7(a-b), and a generally parabolic shaped center portion 69 upon which at least one integrally formed threaded path 20 is formed. As shown, path 20 generally and helically extends around and is selectively formed within the screw portion 69 in the manner shown, by way of example and without limitation, by the paths designated as "T^1" and T^2" within the '346 patent. In another embodiment of this invention, screw 16 is manufactured in accordance with the teachings found within United States Patent Number 4,588,337 ("the '377 patent") which is also fully and completely incorporated herein by reference, word for word and paragraph for paragraph.

In operations, screw 16 rotates around its "central" axis or longitudinal axis of symmetry 70 in the direction of arrow 71 and selectively and movably engages the generally round and/or spherical portions 22 of the rollers 14 which are movably, distributably, and protudingly positioned upon roller wheel 12, thereby

causing the engaged rollers 14 to rotate about their respective longitudinal axis of symmetry 56, thereby causing the roller wheel 12 to selectively rotate in the direction of arrow 72. Particularly, as the screw 16 rotates, the centerline or longitudinal axis of symmetry 75 of path 20 is aligned with the centerline 77 of each portion 22 and the flange 40 becomes disengaged or separated from bearings 64, 66 thereby allowing the bearings 64, 66 to rotate within bore 28 without substantially contacting flange 40. In one non-limiting embodiment of the invention, roller wheel 12 and the screw 16 are selectively and engageably arranged to have the power and/or energy transferred from the screw 16 to the wheel 12 in the rotational directions 71 and 72 which are shown.

The generally rounded and/or spherical screw engagement portions 22 substantially and evenly distributes the engaging force along and/or "around" their generally spherical and respective thread engagement surfaces 22. This rotation and this substantially even distribution of the engagement force substantially eliminates the friction and rubbing and the radial and/or compression type thrust forces which are common in prior power transmission systems. Alternatively, the wheel 12 may selectively operate as an "input shaft" and movably engage a stationery screw 16 to

selectively transfer energy or power from the moving wheel 12 to the screw 16 by use of these selectively rotatable roller pins 14. Assembly 10 may therefore be selectively used as a "speed decreaser" or as a "speed increaser" in the manner described, for example, on lines 32-63 of column 6 of the '346 patent.

Due to the substantially parabolic shape of the screw 16, at least two of the roller pins 22 are almost always engaged within the thread path 20 during the operation of the assembly 10. It should also be understood that a plurality of substantially similar and substantially parallel-running screw threads 18 could be formed within screw 16, as shown in Figure 8, thereby allowing a greater number of roller pins 22 to become selectively engaged within the screw 16 during a particular period or interval of time.

Moreover, in the preferred embodiment of the invention, each threaded path 20 of the screw 16 is also adapted to accept and mate with each substantially spherical portion 22 in a substantially "enveloping" or "overlapping" configuration. That is, each threaded path 20 has a cross-sectional area which is substantially similar to the cross-sectional area of portion 22 and which substantially "matches" the path that each of the roller pins 22 traverse as the screw 14 and the wheel 12 are engagably rotated, thereby causing the each axis 75

of each engaged roller pin 14 to be operatively aligned with the centerline 77 of the path 20.

As should be apparent from the foregoing discussion, assembly 10 obviates the need for thrust bearings and springs within assembly 12, thereby reducing overall assembly cost and increasing the assembly reliability. Moreover, the assembly 10 further increases overall power and energy transfer efficiency by substantially eliminating the "skidding" type friction and compression thrust forces found within prior assemblies. It should be realized that portions 22 may be of virtually any shape which allows the thread engagement forces to be substantially and evenly distributed across the respective portions 22, thereby allowing pins 14 to rotate within being compressed. Further, the various portions 22 may be protrudingly arranged upon surface 24 in a manner which allows these portions 22 to enter path 20 from a variety of angels and/or directions with respect to axis 56.

Referring now to Figures 4-6, there is shown a power transmission assembly and/or "system" 100 which is made in accordance with the teachings of a second and non-limiting embodiment of the present invention. As shown, assembly 100 includes a selectively movable member and/or wheel 102 which, in one non-limiting embodiment, is substantially similar to roller wheel 12, and further

having a plurality of substantially similar and/or identical roller pins 106, and a screw 104 including at least one screw thread 108 which forms at least one path 110. Wheel 102 includes several distributed bores or openings 112 which, in one non-limiting embodiment of the invention, are substantially similar to the previously described bore openings 28 and which are disposed upon wheel 102 in a manner which is similar to the disposition of bores 28 upon wheel 12. The bores 112 are each adapted to removably and securely receive and accept a unique one of the roller pins 106 and a pair of bearings 114, 116, which are substantially and respectively identical to bearings 32, 30.

In one non-limiting embodiment of the invention, roller pins 106 are substantially similar in function and structure to roller pins 14 with the exception that roller pins 106 include a screw engagement portion 118 which differs from screw engagement portions 22 of roller pins 14 and which, in one non-limiting embodiment, is oblong and has a substantially elliptical cross-sectional area. Moreover, screw 104 includes at least one threaded path 110 having a cross-sectional area which is substantially similar to the cross-sectional area of each engagement portion 118 and therefore also differs from the screw 16 and the path 20 which were utilized within the first non-limiting embodiment of the invention. This

second embodiment will now be described in greater detail.

Particularly, each of the roller pins 106 includes a body 120 which is adapted to be removably and rotatably secured within a unique one of the bores 112. In one non-limiting embodiment, the portion of the body 120 which is placed within wheel 102 is substantially similar to and/or identical to the portion of the pin 14 which is selectively placed within the wheel 12. That is, body 120 includes a top portion 147, a flange portion 149, and a bottom portion 151 which are respectively similar to portions 46, 40 and 34 of the previously described roller pin 14. Bores 28 and 112 are also similarly and substantially identical.

Engagement portion 118 terminates within an integrally formed neck 122 which projects from the wheel surface 124 when the pin 106 is selectively and properly inserted into one of the bores 112. Neck 122 has a generally flat top surface 128 and an annular side surface 130. As best shown in Figure 6, radius 132 of one side of annular surface 130 is about 0.3125", the height of portion 118, which is defined as length 134, is about 0.250", the height of neck portion 122, which is defined as length 136, is about 0.133", the height of portion 147 which is defined as length 138 is about 0.441", the height of portion 149 which is defined as

length 140 is about 0.125", the height of portion 151 which is defined as length 142 is about 0.315", the diameter 144 of neck 122 is about 0.500", the diameter 146 of top body portion 147 is about 0.625", the diameter 148 of flange 149 is about 0.725", and the diameter 150 of bottom portion 151 is about 0.500".

In operation, threaded path 110 is adapted to selectively and engagingly receive the portion 118 and to automatically "center" portion 130 within thread path 110, as illustrated in Figures 4 and 5 (i.e., the longitudinal axis of symmetry of the threaded path 110 is aligned with the radius 132.) During this selective engagement, roller pins 106 selectively mate, engage, and are movably received within and rotatably traverse the path 110. Roller pins 106 may enter the path 110 from a variety of different angles with respect to the longitudinal axis of symmetry of path 110 and/or directions. Further, the substantially rounded shape of portion 130 allows the thread engagement forces to be substantially and evenly distributed along surface portion 130, substantially eliminating the previously delineated downward and/or compression forces to the roller pins 106 while allowing the roller pins 106 to rotate along their respective longitudinal axis of symmetry 152, thereby allowing the wheel 102 to selectively rotate in response to rotation of screw 104.

Importantly, assembly 100 also obviates the need for thrust bearings and springs, thereby reducing overall cost and increasing system reliability. Moreover, the present assembly increases efficiency by substantially eliminating the "skidding type" friction caused by the pins of prior assemblies, and the assembly 10 further allows pins 106 to be automatically centered within path 110 and remains centered until leaving the thread path 110.

It should be understood that this invention is not limited to the exact construction or embodiments listed and described but that various changes may be made without departing from the spirit and scope of the invention. For example and without limitation, different types and/or shapes of roller pins may be used which have substantially similar advantages over the roller pins of the prior art. More particularly and without limitation, roller pins having projection portions with elliptical or hyperbolic cross-sections and correspondingly-shaped screw threads could be employed, thereby provides for substantially identical efficiencies as those found in the previously described embodiments of this invention.

WHAT IS CLAIM IS:

(1) An assembly for use in combination with a screw, said assembly comprising;

a body; and

at least one roller which is selectively contained within said body and which has a substantially round screw engagement portion which rotatably engages said screw, thereby causing said at least one roller to rotatably move upon said screw.

(2) The roller wheel of claim 1 wherein said screw engagement portion is spherical.

(3) The roller wheel of claim 1 wherein said screw engagement portion is elliptical.

(4) An assembly comprising a screw having at least one first threaded path; and a member having a plurality of roller pins which respectively include a substantially spherical engagement portion which rotatably moves within at least a portion of said at least one threaded path.

(5) A power transmission assembly comprising;

a member having at least one bore;

a plurality of bearings contained within said bore;

a pin which is movably disposed within said at least one bore and having a round engagement portion which protrudes from said wheel; and

a rotating screw having a threaded path which selectively engages said rounded engagement portion

effective to cause said member to rotate, thereby transferring power between said rotating screw and said member.

(6) The power transmission assembly of claim 5 wherein said engagement portion comprises a sphere.

(7) The power transmission assembly of claim 5 wherein said engagement portion is elliptically shaped.

(8) The power transmission assembly of claim 5 wherein said member comprises a wheel.

(9) A power transmission assembly comprising:

a selectively rotatably screw;

a member;

a pin which is protrudingly disposed within said member which selectively engages said selectively rotatable screw, thereby receiving and distributing a certain amount of engagement force, effective to allow said pin to rotate without being substantially compressed.

(10) The power transmission assembly of claim 9 wherein said member comprises a wheel.

(11) The power transmission system of claim 10 wherein said selectively rotatable screw includes a path having a certain longitudinal axis of symmetry and wherein said pin includes a certain centerline and wherein said certain longitudinal axis of symmetry and said centerline are aligned as said pin selectively engages said screw.

(12) The power transmission system of claim 11 wherein said pin has a spherical portion which engages said screw.

(13) The power transmission system of claim 11 wherein said pin has an elliptical portion which engages said screw.

(14) A method for increasing the power transfer efficiency of a power transmission system of the type having a screw and a member which includes at least one projecting portion which selectively engages said screw, said method comprising the step of forming said projecting portion into a spherical shape.

(15) The method of claim 14 further comprising the steps of forming at least one path within said screw; and causing said projecting portion to movably traverse said path.

(16) The method of claim 15 wherein said at least one path has a longitudinal axis of symmetry and wherein said projecting portion has a centerline, said method further including the steps of aligning said centerline with said longitudinal axis of symmetry as said projection portion movably traverses said path.

(17) The method of claim 16 further comprising the step of operatively placing at least one bearing within said member.

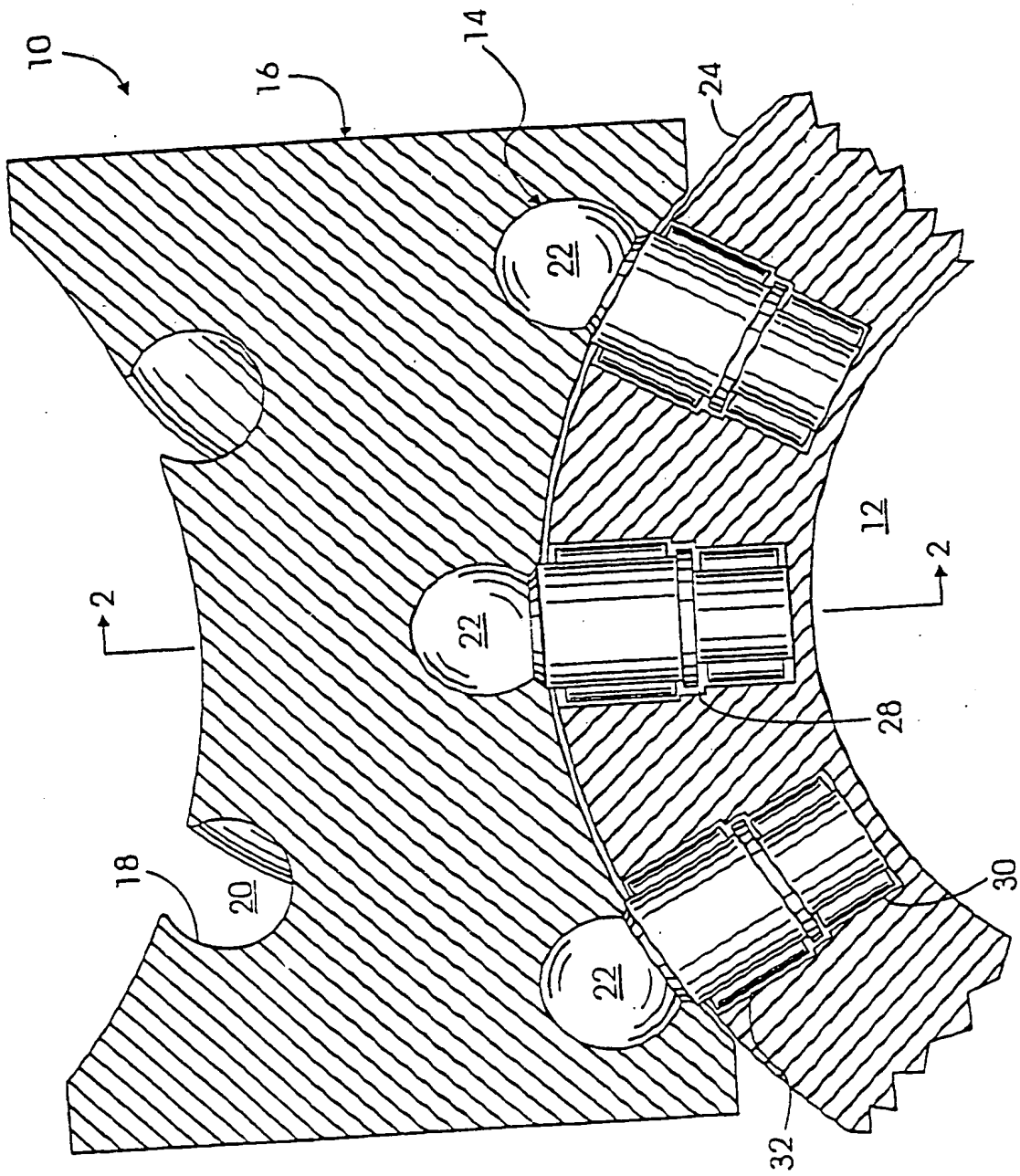

Fig. 1

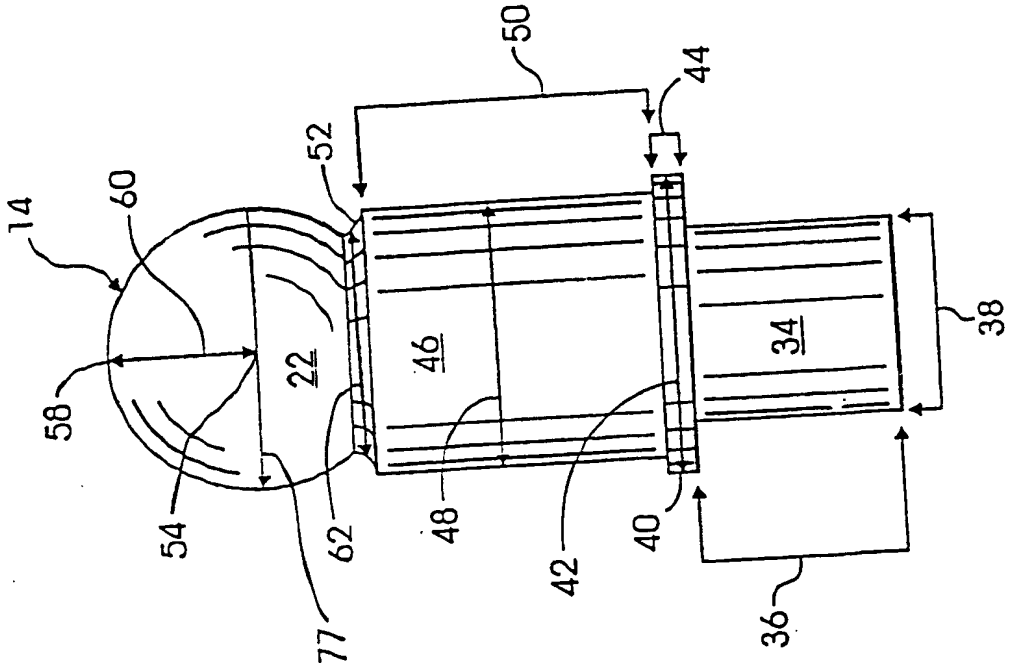
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Fig. 3

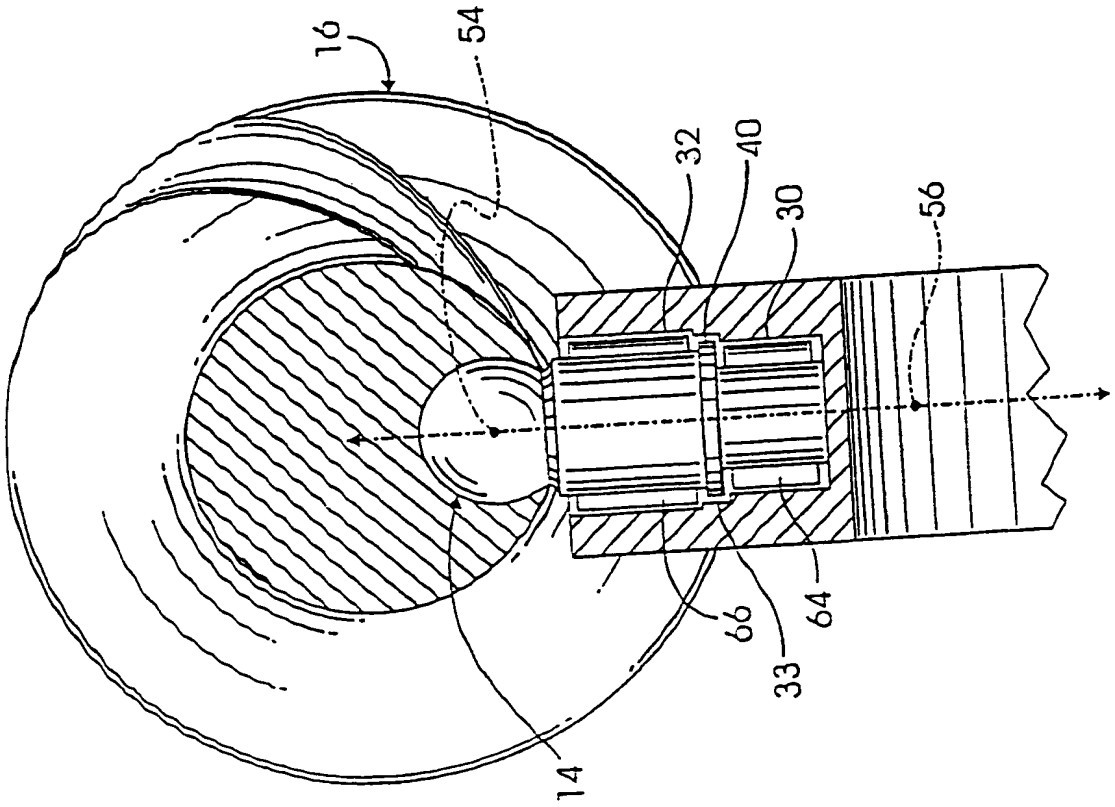
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Fig. 2

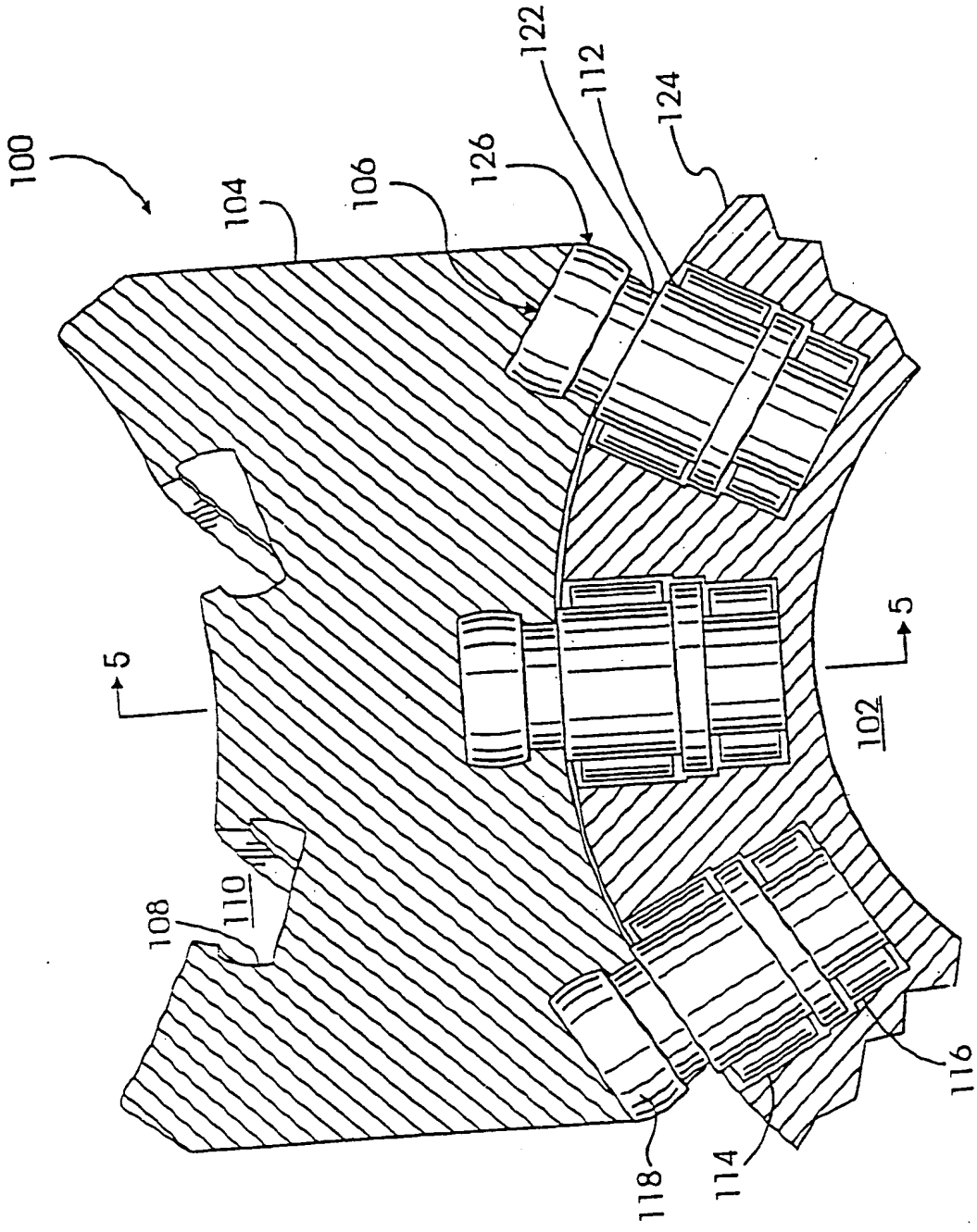

Fig. 4

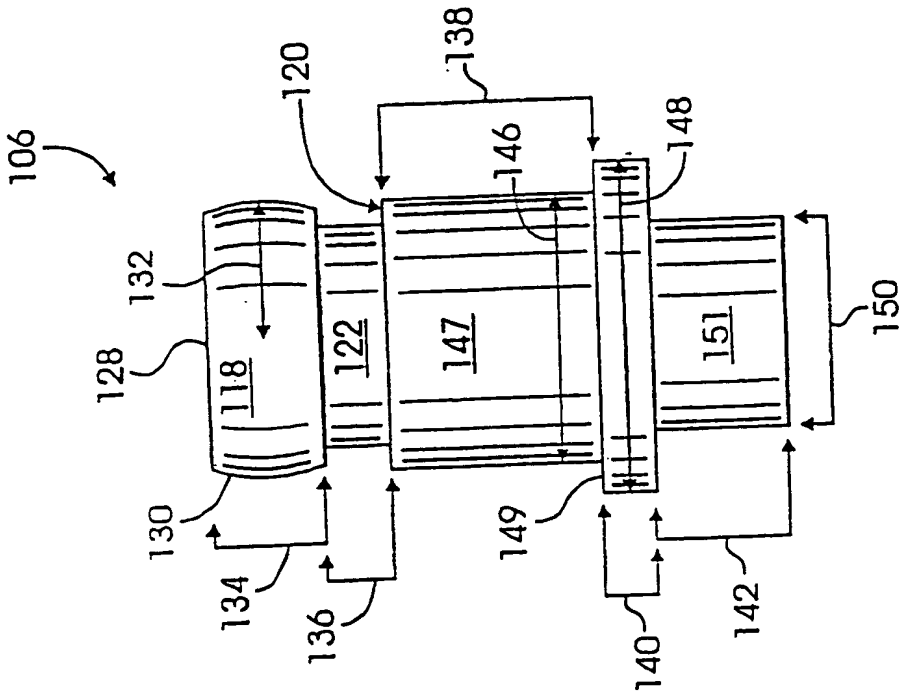
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Fig. 6

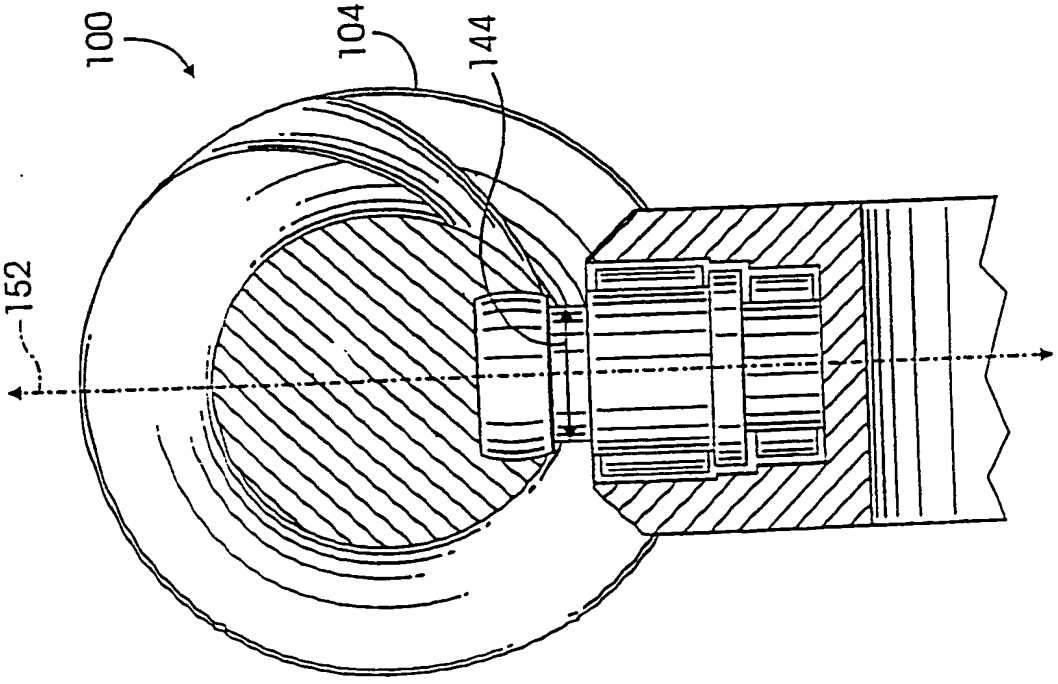
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Fig. 5

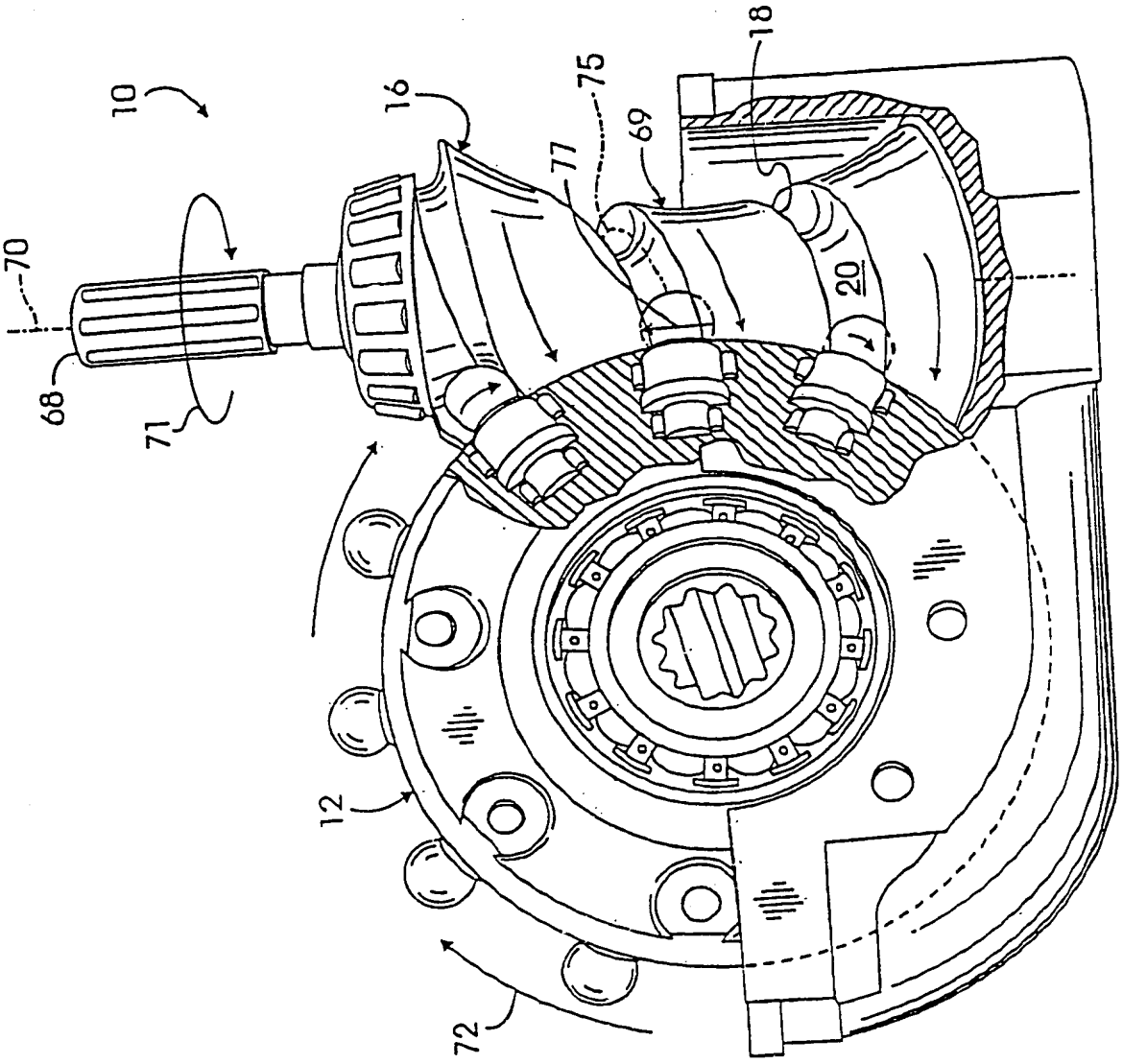

Fig. 7a

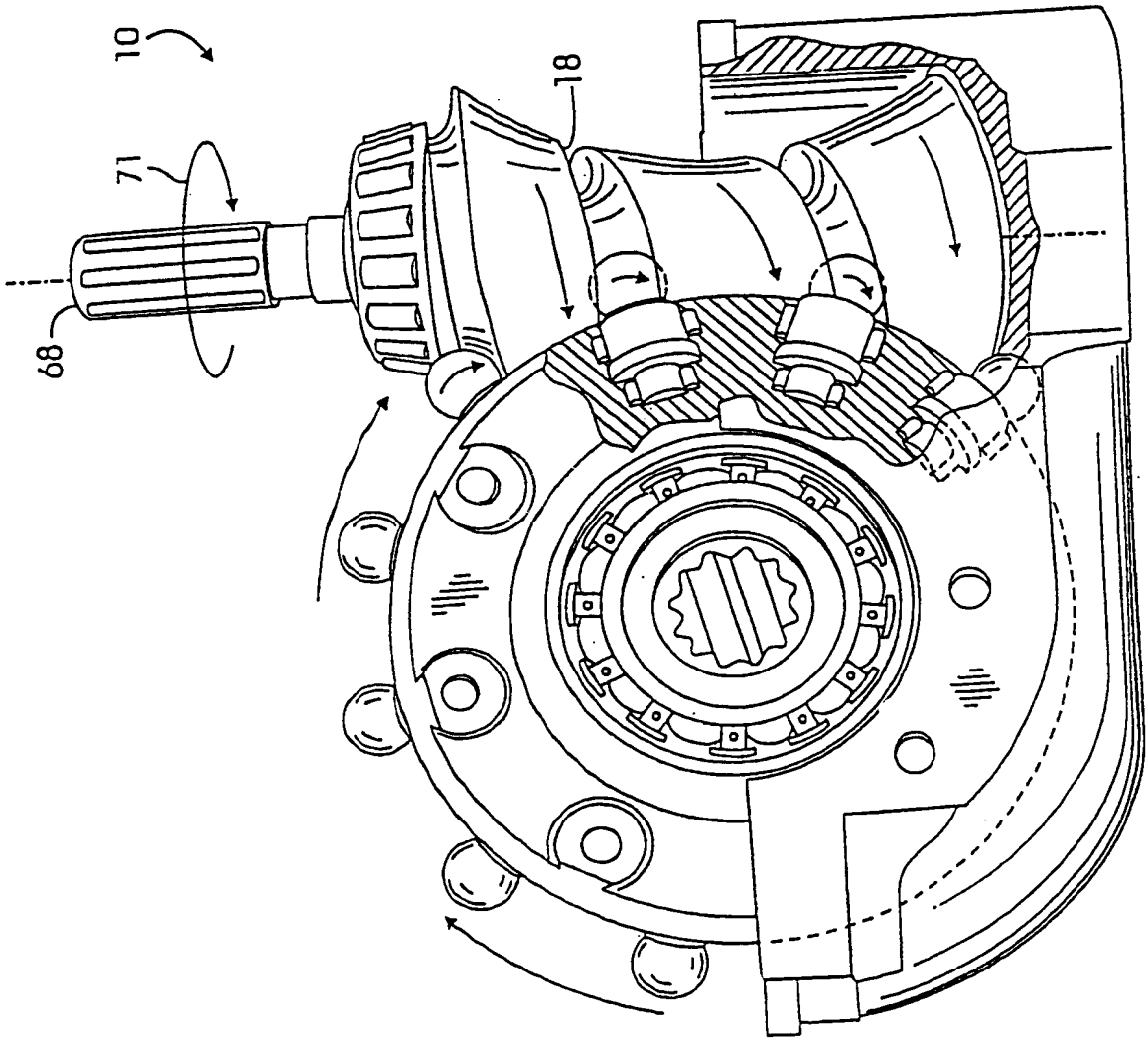

Fig. 7b

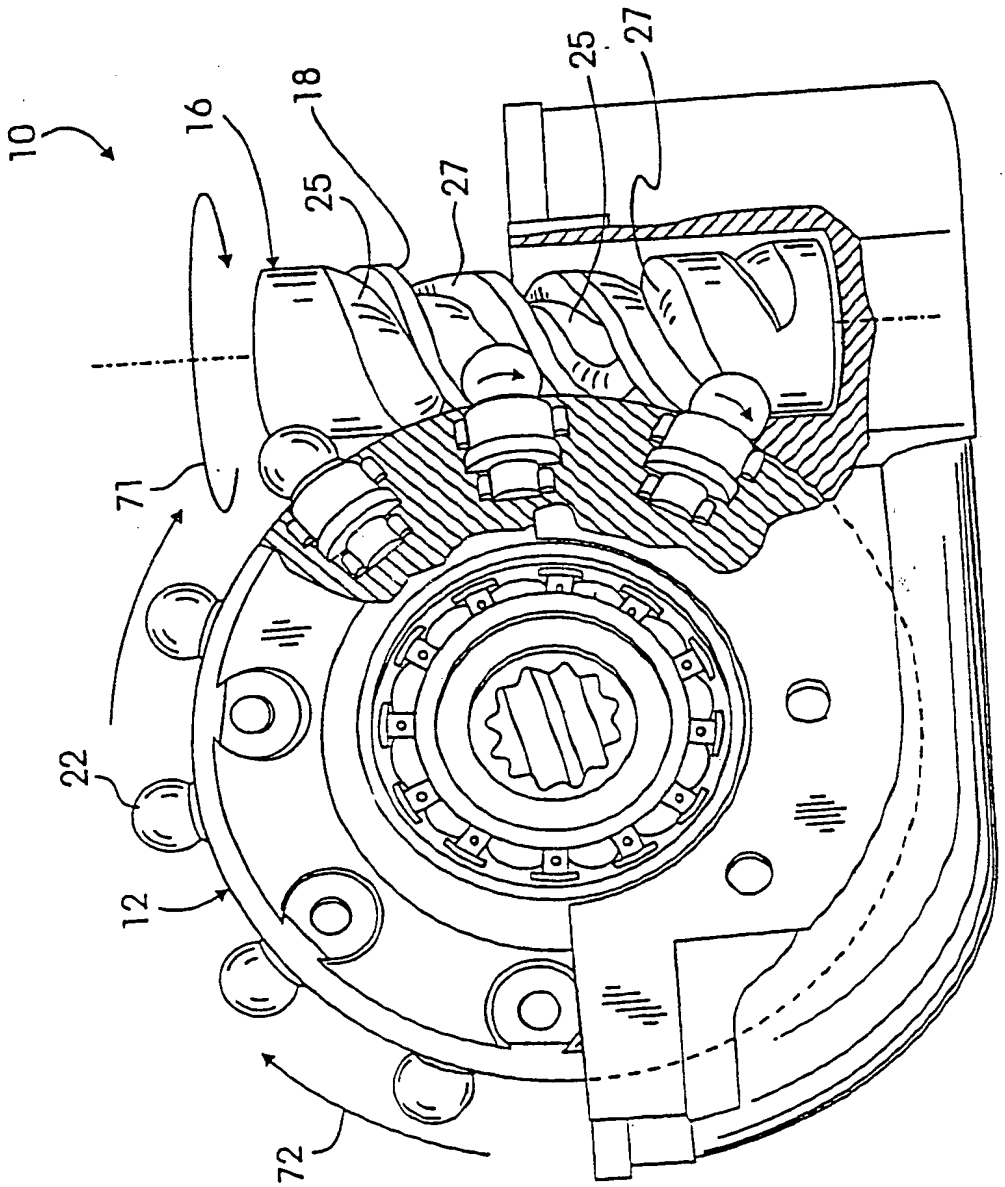

Fig. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/28727

A. CLASSIFICATION OF SUBJECT MATTER
IPC(7) : F16H 1/16; F16H 55/22
US CL : 74/ 89.15, 425, 424.8R, 458, 465
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 74/ 89.15, 425, 424.8R, 458, 465

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 1,060,933 A (Myers) 06 May 1913 (06.05.1913), see Figures 1-3	1,2,4,9-12,14-16
X	US 3,820,413 A (Brackett) 28 June 1974 (28.06.1974), see Figures.	1,3,5,7-11,13
X	US 4,833,934 A (Boyko et al.) 30 May 1989 (30.05.1989), see Figures 1-3.	1,5,8-11
X	US 1,165,974 A (Ingram) 28 December 1915 (28.12.1915), see Figures.	1,2,4-6,8-12,14-17
A	US 3,597,990 A (McCartin) 10 August 1971 (10.08.1971), see Figures.	1-17
A	US 4,665,763 A (James) 19 May 1987 (19.05.1987), see Figures.	1-17
A	US 4,782,716 A (F'Geppert) 08 November 1988 (08.11.1988), see Figures.	1-17

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent published on or after the international filing date
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"O" document referring to an oral disclosure, use, exhibition or other means
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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
02 January 2001 (02.01.2001)	22 JAN 2001
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703)305-3230	Authorized officer David Bucci Diane Smith for Telephone No. (703) 308-1113

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